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(11) **EP 0 763 595 B1**

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
16.01.2002 Bulletin 2002/03

(51) Int Cl.7: **C11D 17/00, C11D 11/00**

(21) Application number: **96202209.1**

(22) Date of filing: **06.08.1996**

(54) Detergent composition

Waschmittelzusammensetzung

Composition détergente

(84) Designated Contracting States:
DE ES FR GB IT

(30) Priority: **30.08.1995 US 520797**

(43) Date of publication of application:
19.03.1997 Bulletin 1997/12

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D scriptionField of the invention

5 [0001] The present invention relates to heavy duty liquid compositions. Preferably, the compositions comprising lamellar droplets, which can be produced by adding sufficient amounts of surfactants and/or electrolytes, and solid structurants.

Background of the invention

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[0002] Structured heavy duty liquids must be able to suspend particles such that these particles do not phase separate (i.e., settle out of solution) and yet they must not be so thick as to effect the pourability of the liquid compositions.

[0003] The dual attribute of suspending power and easy pourability in structured or duotropic liquids currently in the art is accomplished by adding sufficient surfactant and/or electrolyte such that the surfactant forms a disperse, lamellar phase. The prior art liquid compositions are capable of suspending only small (<25 μm) particles such as, for example, zeolites.

15 [0004] Duotropic liquids such as those described above are taught for example in U.S. Patent No. 5,147,576 to Montague et al, WO 91/09107 to Buytenhek et al., EP 0,160,342 A2 to Humphreys et al., EP 0,564,250 A2 to Coope et al. and WO 91/08281 to Foster et al.

20 [0005] The use of solids of the morphology described in the present invention in structured heavy duty liquids is taught in EP 0,086,614 A1 to Akred et al. However, there are significant differences between the solids and the structured liquid composition mentioned in the above specification and those taught in the current specification. These include the dimension of the solids used by Akred et al., the solids of Akred et al. have to form a network (i.e., solids are coordinated with each other rather than being independent) in the structured liquid while those used in the current specification do not form network as evidenced from rheological measurements (structuring by network formation is undesirable since it takes a considerable amount of time to rebuild the network when the structurant is disturbed - for example, during use of the product - and during this rebuilding the solids can settle out time). Furthermore, it is extremely difficult to reproduce the network formation which will reflect in inconsistency in quality of the product formed and the lamellar droplets of the structured liquid used in the current specification are preferably stabilized using a decoupling polymer, while no stabilizing agent is used in Akred et al. Use of decoupling polymer allows incorporation of much higher levels of surfactants into the detergent formulation.

25 [0006] Structured liquids containing decoupling polymers are described in Montague et al. (US 5,147,576) hereby incorporated by reference into the subject application.

30 [0007] While lamellar structured compositions possess shear thinning characteristics to provide suspending power for small particles (less than 25 μm) and maintain pourability, they do not possess sufficient shear thinning property to provide adequate suspending power for large particles (i.e. 200 to 1000 μm) such as, for example, encapsulates of bleach catalysts and enzymes.

Brief summary of the invention

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[0008] Applicants have found that by incorporating solid particles of particular dimension and morphology, it is possible to enhance the shear thinning properties (i.e., the ability to suspend particles without causing a large increase in pour viscosity) of the HDL compositions such that large size particles 200 to 1000 μm (e.g., encapsulates of bleach catalysts and enzymes) may be stably suspended in these compositions while maintaining pourability. Pour viscosity is measured at shear rate of 21 s⁻¹.

45 [0009] Consequently, the present invention relates to a heavy duty liquid composition comprising from greater than 15% to 80% by weight of a surfactant, electrolyte and solid particles having a length of from 3 to 25 μm wherein the width of the solid particles is less than 1 μm and the length is at least 3 times the width, preferably at least 5 times the width, and no less than 3 μm . We have found that these compositions are capable of suspending solid particles up to about 1000 μm in size.

50 [0010] Preferably, the composition comprises more than 20% by weight of surfactant. Preferably, the composition comprises from 0.1 to 60% by weight of electrolyte. The composition comprises from 1 to 25% by weight of the solid particles to be used in the invention.

55 [0011] More specifically, the composition is directed to heavy duty liquid compositions as defined herein before comprising:

(1) more than 20% by weight of a surfactant selected from the group consisting of anionics, nonionics, cationics, zwitterionics, amphoterics and mixtures thereof; and

(2) a solid particle, added directly or formed in situ, wherein the length of the particle is from 3 to 20 μm in size;

said compositions capable of suspending particles from 200 to 1000 μm in size.

[0012] Said compositions preferably comprise a decoupling or deflocculating polymer (e.g., acrylate/polymethacrylate copolymer having molecular weight of 3,000 to 15,000).

Detailed description of the invention

[0013] In one embodiment, the present invention relates to heavy duty liquid compositions which are lamellar structured (so-called "duotropic" liquids) and which additionally comprise solid particles or a mixture of solid particles which are added either directly or formed in situ wherein at least one side of said particle or particles has a length or width of from 3 to 20 μm (microns).

[0014] Unexpectedly, applicants have found that addition of solid or mixture of solids having defined morphology to such heavy duty liquid compositions allows the compositions to suspend particles larger than those previously possible to suspend (i.e. 200 to 1000 μm).

[0015] More specifically, the invention is a liquid detergent composition comprising:

(1) greater than 20%, preferably 25% to 80% by weight of one or more surfactants predominantly present as lamellar droplets dispersed in an aqueous medium containing 0.1%, preferably at least 7%, more preferably at least 15% by weight, to 60% by weight electrolyte;

(2) 0.1 to 5% by weight of a deflocculating polymer; and

(3) 1% to 25%, preferably 3% to 15% by wt. of a solid particle, added directly or formed in situ, wherein having a length of from 3 to 20 μm .

[0016] The width of the particle is less than 1 μm and the length (being no less than 3 μm) is at least 3 times the width, preferably 5 times the width.

[0017] The larger the length is relative to the width (i.e., the more "needle-like" the solid), the greater is the suspending power which was observed.

[0018] These compositions are capable of suspending particles from 200 to 1000 μm in size. Of course, it will be understood that the compositions can suspend particles below 200 μm in size if they can suspend large particles. But for smaller particles (<25 μm), the suspension provided by the "needle-like" suspending particles may not be required, but it could be useful.

Lamellar Compositions

[0019] As noted, compositions of the art have used surfactants in the form of lamellar dispersions to support smaller particles (under 25 μm) while retaining adequate pourability (shear thinning).

[0020] Lamellar droplets are a particular class of surfactant structures which, inter alia, are already known from a variety of references, e.g. H. A. Barnes, 'Detergents', Ch. 2. in K. Walters (Ed), 'Rheometry: Industrial Applications', J. Wiley & Sons, Letchworth 1980.

[0021] Such lamellar dispersions are used to endow properties such as consumer-preferred flow behavior and/or turbid appearance. Many are also capable of suspending particulate solids such as detergency builders or abrasive particles. Examples of such structured liquids without suspended solids are given in U.S. Patent No. 4,244,840, while examples where solid particles are suspended are disclosed in specifications EP-A-160,342; EP-A-38,101; EP-A-104,452 and also in the aforementioned US 4,244,840. Others are disclosed in European Patent Specification EP-A-151,884, where the lamellar droplet are called 'spherulites'.

[0022] The presence of lamellar droplets in a liquid detergent product may be detected by means known to those skilled in the art, for example optical techniques, various rheometrical measurements, X-ray or neutron diffraction, and electron microscopy.

[0023] The droplets consists of an onion-like configuration of concentric bi-layers of surfactant molecules, between which is trapped water or electrolyte solution (aqueous phase). Systems in which such droplets are close-packed provide a very desirable combination of physical stability and solid-suspending properties with useful flow properties.

[0024] In such liquids, there is a constant balance sought between stability of the liquid (generally, higher volume fraction of the dispersed lamellar phase, i.e., droplets, give better stability), the viscosity of the liquid (i.e., it should be viscous enough to be stable but not so viscous as to be unpourable) and solid-suspending capacity (i.e., volume fraction high enough to provide stability but not so high as to cause unpourable viscosity).

[0025] A complicating factor in the relationship between stability and viscosity on the one hand and, on the other, the volume fraction of the lamellar droplets is the degree of flocculation of the droplets. When flocculation occurs between the lamellar droplets at a given volume fraction, the viscosity of the corresponding product will increase owing to the formation of a network throughout the liquid. Flocculation may also lead to instability because deformation of the lamellar droplets, owing to flocculation, will make their packing more efficient.

[0026] Consequently, more lamellar droplets will be required for stabilization by the space-filling mechanism, which will again lead to a further increase of the viscosity.

[0027] The volume fraction of droplets is increased by increasing the surfactant concentration and flocculation between the lamellar droplets occurs when a certain threshold value of the electrolyte concentration is crossed at a given level of surfactant (and fixed ratio between any different surfactant components). Thus, in practice, the effects referred to above mean that there is a limit to the amounts of surfactant and electrolyte which can be incorporated while still having an acceptable product. In principle, higher surfactant levels are required for increased detergency (cleaning performance). Increased electrolyte levels can also be used for better detergency, or are sometimes sought for secondary benefits such as building.

pH-Jump HDL

[0028] A sub-class of lamellar dispersions included in the liquid detergent compositions, or HDLs, relevant to this invention are pH-jump HDLs. A pH-jump HDL is a liquid detergent composition containing a system of components designed to adjust the pH of the wash liquor. It is well known that organic peroxyacid bleaches are most stable at low pH (3- 7), whereas they are most effective as bleaches in moderately alkaline pH (7.5-9) solution. Peroxyacids such as 1,2-diperoxy dodecanedionic acid DPDA cannot be feasibly incorporated into a conventional alkaline heavy duty liquid because of chemical instability. Other peroxyacids which can be used include, but not limited to, phthalimidop-erhexanoic acid (PAP) and N,N'-terephthaloyl-di-6-amino percaproic acid (TPCAP). To achieve the required pH regimes, a pH jump system can be employed in this invention to keep the pH of the product low for peracid stability yet allow it to become moderately high in the wash for bleaching and detergency efficacy. One such system is borax 10H₂O/polyol. Borate ion and certain cis 1,2 polyols complex when concentrated to cause a reduction in pH. Upon dilution, the complex dissociates, liberating free borate to raise the pH. Examples of polyols which exhibit this complexing mechanism with borax include catechol, galactitol, fructose, sorbitol and pinacol. For economic reasons, sorbitol is the preferred polyol.

[0029] Sorbitol or equivalent component (i.e., 1,2 polyols noted above) is used in the pH jump formulation in an amount from 1 to 25% by wt., preferably 3 to 15% by wt. of the composition.

[0030] Borate or boron compound is used in the pH jump composition in an amount from 0.5 to 10.0% by weight of the composition, preferably 1 to 5% by weight.

[0031] Bleach component is used in the pH jump composition in an amount from 0.5 to 10.0% by weight of the composition, preferably 1 to 5% by weight.

Electrolytes

[0032] As used herein, the term electrolyte means any ionic water-soluble material. However, in lamellar dispersions, not all the electrolyte is necessarily dissolved but may be suspended as particles of solid because the total electrolyte concentration of the liquid is higher than the solubility limit of the electrolyte. Mixtures of electrolytes also may be used, with one or more of the electrolytes being in the dissolved aqueous phase and one or more being substantially only in the suspended solid phase. Two or more electrolytes may also be distributed approximately proportionally, between these two phases. In part, this may depend on processing, e.g the order of addition of components. On the other hand, the term 'salts' includes all organic and inorganic materials which may be included, other than surfactants and water, whether or not they are ionic, and this term encompasses the sub-set of the electrolytes (water-soluble materials).

[0033] The compositions of the invention contain electrolyte in an amount sufficient to bring about structuring of the detergent surfactant material. Preferably though, the compositions contain from 0.1% to 60%, more preferably from 7 to 45%, most preferably from 15% to 30% of a salting-out electrolyte. Salting-out electrolyte has the meaning ascribed to in specification EP-A-79646, i.e. salting-out electrolytes have a lyotropic number of less than 9.5, preferably less than 9.0. Examples are sulphate, citrate, phosphate, NTA and carbonate. Optionally, some salting-in electrolyte (as defined in the latter specification) may also be included, provided if of a kind and in an amount compatible with the other components and the compositions is still in accordance with the definition of the invention claimed herein.

Surfactants

[0034] A very wide variation in surfactant types and levels is possible. The selection of surfactant types and their

proportions, in order to obtain a stable liquid with the required structure will be fully within the capability of those skilled in the art. However, it can be mentioned that an important sub-class of useful compositions is those where the detergent surfactant material comprises blends of different surfactant types. Typical blends useful for fabric washing compositions include those where the primary surfactant(s) comprise nonionic and/or a non-alkoxylated anionic and/or an alkoxylated anionic surfactant.

[0035] The total detergent surfactant material in the present invention is present at from greater than 15% to 80% by weight of the total composition, preferably from greater than 20% to 50% by weight.

[0036] In the case of blends of surfactants, the precise proportions of each component which will result in such stability and viscosity will depend on the type(s) and amount(s) of the electrolytes, as is the case with conventional structured liquids.

[0037] In the widest definition the detergent surfactant material in general, may comprise one or more surfactants, and may be selected from anionic, cationic, nonionic, zwitterionic and amphoteric species, and (provided mutually compatible) mixtures thereof. For example, they may be chosen from any of the classes, sub-classes and specific materials described in 'Surface Active Agents' Vol. I, by Schwartz & Perry, Interscience 1949 and 'Surface Active Agents' Vol. II by Schwartz, Perry & Berch (Interscience 1958), in the current edition of "McCutcheon's Emulsifiers & Detergents" published by the McCutcheon division of Manufacturing Confectioners Company or in 'Tensid-Taschenbuch', H. Stache, 2nd Edn., Carl Hanser Verlag, Munchen & Wien, 1981.

[0038] Suitable-nonionic surfactants include, in particular, the reaction products of compounds having a hydrophobic group and a reactive hydrogen atom, for example aliphatic alcohols, acids, amides or alkyl phenols with alkylene oxides, especially ethylene oxide, either alone or with propylene oxide. Specific nonionic detergent compounds are alkyl (C_8-C_{18}) primary or secondary, linear or branched alcohols with ethylene oxide, and products made by condensation of ethylene oxide with the reaction products of propylene oxide and ethylenediamine. Other so-called nonionic detergent compounds include long chain tertiary amine oxides, long-chain tertiary phosphine oxides and dialkyl sulphoxides.

[0039] Other suitable nonionics which may be used include aldobionamides such as are taught in U.S. No. 5,389,279 to Au et al. and polyhydroxyamides such as are taught in U.S. Patent No. 5,312,954 to Letton et al.

[0040] Suitable anionic surfactants are usually water-soluble alkali metal salts of organic sulphates and sulphonates having alkyl radicals containing from about 8 to about 22 carbon atoms, the term alkyl being used to include the alkyl portion of higher acyl radicals. Examples of suitable synthetic anionic detergent compounds are sodium and potassium alkyl sulphates, especially those obtained by sulphating higher (C_8-C_{18}) alcohols produced, for example, from tallow or coconut oil, sodium and potassium alkyl (C_8-C_{20}) benzene sulphonates, particularly sodium linear secondary alkyl ($C_{10}-C_{15}$) benzene sulphonates; sodium alkyl glyceryl ether sulphates, especially those ethers of the higher alcohols derived from tallow or coconut oil and synthetic alcohols derived from petroleum; sodium coconut oil fatty monoglyceride sulphates and sulphonates; sodium and potassium salts of sulfuric acid esters of higher (C_8-C_{18}) fatty alcohol-alkylene oxide, particularly ethylene oxide, reaction products; the reaction products of fatty acids such as coconut fatty acids esterified with isethionic acid and neutralized with sodium hydroxide; sodium and potassium salts of fatty acid amides of methyl taurine; alkane monosulphonates such as those derived by reacting alpha-olefins (C_8-C_{20}) with sodium bisulphite and those derived from reacting paraffins with SO_2 and Cl_2 and then hydrolyzing with a base to produce a random sulphonate; and olefin sulphonates, which term is used to describe the material made by reacting olefins, particularly $C_{10}-C_{20}$ alpha-olefins, with SO_3 and then neutralizing and hydrolyzing the reaction product. The preferred anionic detergent compounds are sodium ($C_{11}-C_{15}$) alkyl benzene sulphonates and sodium ($C_{10}-C_{18}$) alkyl sulphates.

[0041] It is also possible to include an alkali metal soap of a long chain mono- or dicarboxylic acid for example one having 12 to 18 carbon atoms at low levels, for example less than 2% by weight of the composition. Higher levels of unsaturated fatty acid soaps, such as oleic acid and salts thereof, for example, would impart an undesirable odor and reduce the foam level of the composition.

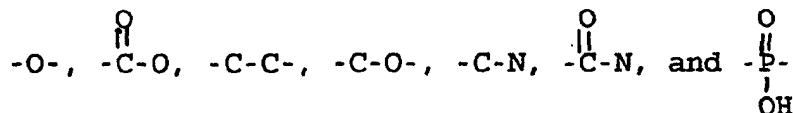
Polymer

[0042] The polymer of the preferred embodiment of the invention is one which, as noted above, has previously been used in structured (i.e. lamellar) compositions such as those described in US 5,147,576 to Montague et al. This is because the polymer allows the incorporation of greater amounts of surfactants and/or electrolytes than would otherwise be compatible with the need for a stable, low-viscosity product as well as the incorporation, if desired, of greater amounts of other ingredients to which lamellar dispersions are highly stability-sensitive.

[0043] The hydrophilic backbone generally is a linear, branched or highly cross-linked molecular composition containing one or more types of relatively hydrophobic monomer units where monomers preferably are sufficiently soluble to form at least a 1% by weight solution when dissolved in water. The only limitations to the structure of the hydrophilic backbone are that they be suitable for incorporation in an active structured aqueous liquid composition and that a polymer corresponding to the hydrophilic backbone made from the backbone monomeric constituents is relatively water soluble (solubility in water at ambient temperature and at pH of 3.0 to 12.5 is preferably more than 1 g/l). The hydrophilic

backbone is also preferably predominantly linear, e.g., the main chain of backbone constitutes at least 50% by weight, preferably more than 75%, most preferably more than 90% by weight.

[0044] The hydrophilic backbone is composed of monomer units selected from a variety of units available for polymer preparation and linked by any chemical links including



[0045] Preferably, the hydrophobic side chains are part of a monomer unit which is incorporated in the polymer by copolymerizing hydrophobic monomers and the hydrophilic monomer making up the backbone. The hydrophobic side chains preferably include those which when isolated from their linkage are relatively water insoluble, i.e., preferably less than 1 g/l, more preferred less than 0.5 g/l, most preferred less than 0.1 g/l of the hydrophobic monomers, will dissolve in water at ambient temperature at pH of 3.0 to 12.5.

[0046] Preferably, the hydrophobic moieties are selected from siloxanes, saturated and unsaturated alkyl chains, e.g., having from 5 to 24 carbons, preferably 6 to 18, most preferred 8 to 16 carbons, and are optionally bonded to hydrophilic backbone via an alkoxy or polyalkoxy linkage, for example a polyethoxy, polypropoxy, or butyloxy (or mixtures of the same) linkage having from 1 to 50 alkoxy groups. Alternatively, the hydrophobic side chain can be composed of relatively hydrophobic alkoxy groups, for example, butylene oxide and/or propylene oxide, in the absence of alkyl or alkenyl groups.

[0047] Monomer units which made up the hydrophilic backbone include:

(1) unsaturated, preferably mono-unsaturated, C_{1-6} acids, ethers, alcohols, aldehydes, ketones or esters such as monomers of acrylic acid, methacrylic acid, maleic acid, vinyl-methyl ether, vinyl sulphonate or vinylalcohol obtained by hydrolysis of vinyl acetate, acrolein;

(2) cyclic units, unsaturated or comprising other groups capable of forming inter-monomer linkages, such as saccharides and glucosides, alkoxy units and maleic anhydride;

(3) glycerol or other saturated polyalcohols.

[0048] Monomeric units comprising both the hydrophilic backbone and hydrophobic side chain may be substituted with groups such as amino, amine, amide, sulphonate, sulphate, phosphonate, phosphate, hydroxy, carboxyl and oxide groups.

[0049] The hydrophilic backbone is preferably composed of one or two monomer units but may contain three or more different types. The backbone may also contain small amounts of relatively hydrophilic units such as those derived from polymers having a solubility of less than 1 g/l in water provided the overall solubility of the polymer meets the requirements discussed above. Examples include polyvinyl acetate or polymethyl methacrylate.

[0050] The level of deflocculating polymer in the present invention is 0.1% to 20% by weight, preferably 0.5% to 5% by weight, most preferably 1% to 3% by weight.

[0051] The compositions of Montague et al., however, even with deflocculating polymer, have poor solids suspending ability. This is evidenced by applicants visual observation of instability when particles in the size range of 200 to 1000 μm , with a density that differed from the liquid density by .2 to .3 specific gravity units, were placed in such liquids.

[0052] In Applicants copending U.S. No. 5 750 489 to Garcia et al., applicants used a substantially linear, water soluble, highly salt tolerant, non-adsorbing ionic polymer to increase suspending power. The solids of the invention, as discussed below, are completely different materials for enhancing particle suspension.

Solid Particles

[0053] The solid particle of the invention is any solid meeting the morphological characteristics defining the invention. That is, the solid or mixture of solids may be any solid added or formed in situ from the salt, wherein at least one side of the solid has a length or width of from 3 to 25 μm , preferably 3 to 15 μm , more preferably 3 to 10 μm , i.e. about the same size as that of the lamellar drops. While not wishing to be bound by theory, it is believed that the particles should be about the same size as the lamellar droplets but not much larger because, if they are too large, the composition may more readily phase separate.

[0054] The width of the particle is less than 1 μm and the length, being at least 3 μm in size, is at least three times, preferably at least 5 to 20 times the width. As noted, the length of the particle may be from 3 to 25 microns. Again, in principle the length may be longer as long as it is not so long as to sediment. Indeed, the more "needle-like" the particle, the better it is believed to be for purposes of the invention (i.e., enhanced suspending while not increasing the pour viscosity).

[0055] The particle can be any particle meeting the required ratio of one side to another and having at least one side 3 to 25 μm while maintaining those physical characteristics (i.e., dimensions and morphology) in the formulation. Example of particles with the dimensions which have been used are calcium citrate, and TPCAP (N,N'-tetraphthaloyl-di-6-aminocaproic peracid). Examples of salts used to precipitate in-situ the needle shaped particles of defined dimension and morphology are gypsum (calcium sulfate dihydrate), calcium chloride and strontium chloride. Other examples of particles of this dimension and morphology, may be found in the CRC Handbook of Physics and Chemistry.

[0056] The particles are added or formed in-situ varying in the range from 1 to 25%, preferably 3 to 15% by weight of the composition.

Other Ingredients

[0057] Preferably the amount of water in the composition is from 5 to 75%, more preferred from 20 to 60% by wt.

[0058] Some or all of the electrolyte (whether salting-in or salting-out), or any substantially water-insoluble salt which may be present, may have detergency builder properties. In any event, it is preferred that compositions according to the present invention include detergency builder material, some or all of which may be electrolyte. The builder material is any capable of reducing the level of free calcium ions in the wash liquor and will preferably provide the composition with other beneficial properties such as the generation of an alkaline pH, the suspension of soil removed from the fabric and the dispersion of the fabric softening clay material.

[0059] Examples of phosphorous-containing inorganic detergency builders, when present, include the water-soluble salts, especially alkali metal pyrophosphates, orthophosphates, polyphosphates and phosphonates. Specific examples of inorganic phosphate builders include sodium and potassium tripolyphosphates, phosphates and hexametaphosphates. Phosphonate sequestrant builders may also be used.

[0060] Examples of non-phosphorus-containing inorganic detergency builders, when present, include water-soluble alkali metal carbonates, bicarbonates, silicates and crystalline and amorphous aluminosilicates. Specific examples include sodium carbonate (with or without calcite seeds), potassium carbonate, sodium and potassium bicarbonates, silicates and zeolites.

[0061] In the context of inorganic builders, we prefer to include electrolytes which promote the solubility of other electrolytes, for example use of potassium salts to promote the solubility of sodium salts. Thereby, the amount of dissolved electrolyte can be increased considerably (crystal dissolution) as described in UK patent specification GB 1,302,543.

[0062] Examples of organic detergency builders, when present, include the alkaline metal, ammonium and substituted ammonium polyacetates, carboxylates, polycarboxylates, polyacetyl carboxylates, carboxymethyl oxysuccinates, carboxymethyloxymalonates, ethylene diamine-N,N, disuccinic acid salts, polyepoxysuccinates, oxydiacetates, triethylene tetramine hexacetic acid salts, N-alkyl imino diacetates or dipropionates, alpha sulpho-fatty acid salts, dipicolinic acid salts, oxidized polysaccharides, polyhydroxysulphonates and mixtures thereof.

[0063] Specific examples include sodium, potassium, lithium, ammonium and substituted ammonium salts of ethylenediaminetetraacetic acid, nitrilotriacetic acid, oxydisuccinic acid, melitic acid, benzene polycarboxylic acids and citric acid, tartrate mono succinate and tartrate di-succinate.

[0064] Although it is possible to incorporate minor amounts of hydrotropes such as lower alcohols (e.g., ethanol) or alkanolamines (e.g., triethanolamine), in order to ensure integrity of the lamellar dispersion we prefer that the compositions of the present invention are substantially free from hydrotropes. By hydrotrope is meant any water soluble agent which tends to enhance the solubility of surfactants in aqueous solution.

[0065] Apart from the ingredients already mentioned, a number of optional ingredients may also be present, for example lather boosters such as alkanolamides, particularly the monoethanolamides derived from palm kernel fatty acids and coconut fatty acids, fabric softeners such as clays, amines and amine oxides, lather depressants, oxygen-releasing bleaching agents such as sodium perborate and sodium percarbonate, peracid bleach precursors, chlorine-releasing bleaching agents such as trichloro-isocyanuric acid, inorganic salts such as sodium sulphate, and usually present in very minor amounts, fluorescent agents, perfumes, enzymes such as proteases, amylases and lipases (including Lipolase (Trade Mark) ex Novo), germicides and colorants.

Process of preparation

[0066] Liquid compositions of the invention may be prepared by any conventional method for the preparation of liquid

detergent compositions.

[0067] However, we have found a particularly preferred method of preparing the liquids. Consequently, the present invention further relates to a process of preparing a heavy duty liquid composition as defined in the claim

[0068] The preferred method, for example, involves the dispersing of the electrolyte ingredient together with the minor ingredients except for the temperature and pH sensitive ingredients, such as enzymes, perfumes, etc -if any- in water of elevated temperature, followed by the addition of the builder material -if any-, the surfactant material (possibly as a premix) under stirring and thereafter cooling the mixture and adding any temperature and pH sensitive minor ingredients. The deflocculating polymer may for example be added after the electrolyte ingredient or as the final ingredient. Preferably the deflocculating polymer are added prior to the formation of the lamellar structure.

Use

[0069] In use, the detergent compositions of the invention will be diluted with wash water to form a wash liquor for instance for use in a washing machine. The concentration of liquid detergent composition in the wash liquor is preferably from 0.1 to 10 %, more preferred from 0.1 to 3% by weight.

[0070] The following examples are intended to be for illustrative purposes only and are not intended to limit the claims in any way.

Examples

[0071] Unless stated otherwise all percentages, in the examples are in the specification are percentages by weight.

Surfactants: Linear alkylbenzenesulfonic acid (LAS acid) and Neodol 25-9 (alcohol ethoxylate; C₁₂₋₁₅ EO₉) were of commercial grade and were supplied by Vista Chemicals and Shell Chemicals respectively.

Polymer: Decoupling polymer (Narlex DC1) was obtained from National Starch and Chemicals. The polymer was an acrylate/lauryl methacrylate copolymer having MW of 3800 Daltons.

Inorganic Reagents: Sodium citrate dihydrate used was of analytical reagent grade and was purchased from Aldrich Chemicals. 50 weight percent sodium hydroxide of analytical reagent grade was supplied by Fisher Scientific Company. Magnesium chloride, calcium chloride, and barium chloride were purchased from Fisher Scientific Company.

Other reagents: Milli Q water was used in all the formulations and for reagent dilution.

Solids: Gypsum (calcium sulfate dihydrate) was purchased from Mallinkrodt and TPCAP from Solvay-Interox and calcium citrate tetrahydrate from Pfaltz and Bauer.

Model Formulation: The following composition was prepared by first adding sodium citrate to water. After dissolution of sodium citrate, that is after the solution became visibly clear, 50% solution of sodium hydroxide was added followed by the structuring solids (or salts), the decoupling polymer (Narlex DC-1) and the detergent surfactants (premix of LAS acid and Neodol 25-9) in that sequence. The composition was continuously stirred and maintained at 55°C during the additions. After completion of surfactants addition, stirring was continued for 30 minutes after which the formulation was cooled down to room temperature.

Formulation Composition	
Component	Parts
Linear Alkyl Benzene Sulfonic (LAS) acid	21.0 - 31.5
Neodol 25-9	9.0 - 13.5
Total surfactants	30.0 - 45.0
NaOH (50% solution)	5.3 - 8.0
Na-citrate 2H ₂ O	14.2 - 18.4
Structuring solids or salts	0 - 8.0
Narlex DC-1 (33% solution)	4.5
Deionized water	up to 100 parts

These ratios were maintained constant in various formulations:

LAS acid/50% NaOH = 4.0 and LAS acid/Neodol 25.9 = 2.33

pH-jump Formulation

[0072] The following composition, to be referred to as "pH jump formulation", was prepared by first adding sodium citrate and sodium borate to water. After dissolution of citrate and borate, that is after the solution became visibly clear, desired amount of a 70 wt.% aqueous solution of sorbitol was added followed by 50% solution of sodium hydroxide, structuring solids (or salts) ethylenediamine tetraacetic acid (EDTA), the fluorescer, the decoupling polymer (Narlex DC-1) and the detergent surfactants (premix of LAS acid and Neodol 25-9) in that sequence. The composition was continuously stirred and maintained at 55°C during the additions. After completion of surfactants addition, stirring was continued to 30 minutes after which the formulation was cooled down to the room temperature ($\approx 25^\circ\text{C}$). Required amount of a 30 weight percent slurry of peracid bleach (TPCAP, N,N'-tetraphthaloyl-di-6-aminocaproic peracid) was then added to the formulation and the stirring continued until the particles were homogeneously dispersed, that is until no clumps of the wet cake were seen.

Formulation Composition		
Component	Parts	
	Composition A (High active)	Composition B (Low active)
LAS acid	22.7	15.4
Neodol 25-9	10.4	6.6
Total surfactants	33.1	22.0
50% NaOH	5.7	3.7
Na-citrate 2H ₂ O	10.0	7.5
Sodium sulfate	-	-
Borax 5 H ₂ O	3.2	2.0
Sorbitol (70 wt.% solution)	13.7	8.7
Gypsum	0 - 8.0	0 - 8.0
TPCAP (30% slurry)	0 - 15	0 - 8.0
Narlex DC-1 (33% solution)	3 - 4.5	3 - 4.5
Fluorescer	0.2	-
EDTA	0 - 0.9	0 - 0.9
Deionized water	up to 100 parts	

Example 1 - Comparative

[0073] Effect of solids of platelet morphology on the rheological properties of the model formulation.

Solid		Platelet Dimension, μm	Viscosity, Pas		Viscosity Ratio**
Type	Wt. %		@ 0.2 Pa	@ 21s ⁻¹	
None	-	-	0.9	0.27	3.4
Bentonite	4.0	$\approx 0.3 \times 0.3^*$	11.9	1.66	7.2
TPCAP	4.5	$\sim 4 \times 4$	26.8	0.92	29.1

* From "An Introduction to Clay Colloid Chemistry" by H. van Olphen, Wiley Interscience, Chap. 1, 1977.

** Viscosity ratio = (Visc. at 0.2 Pa)/(Visc. at 21s⁻¹)

0.2 Pa represents the stress exerted by a particle of 1000 μm in size, with a density difference between the particle and the suspending medium of 0.12 gm/cm³. This represents a typical enzyme capsule that is used in bleach containing liquids. 21s⁻¹ represents shear rate during pouring. The viscosity at 0.2 Pa should be as high as possible to suspend the particles for a very long time while the viscosity at 21s⁻¹ should be as low as possible to make the liquid easily pourable. Therefore, ideally viscosity ratio should be as high as possible.

[0074] This example shows that addition of solid of platelet morphology does improve the viscosity ratio, a measure of shear thinning. However, the dimension of the particle has a significant effect. While bentonite has only a marginal effect with respect to enhancement of the viscosity ratio, the effect of TPCAP is significant. It is to be noted that the dimension of the TPCAP platelet is similar to that of lamellar droplets. The average median size of the lamellar droplet in the formulations described in all the examples vary in the range of 3 to 8 microns (Spherical diameter).

Example 2 - Comparative

[0075] Effect of specific solids of needle shape on the rheological properties of the model formulation.

Solids		Needle Dimension, μm	Viscosity, Pas		Viscosity Ratio
Type	Wt. %		@ 0.2 Pa	@ 21s^{-1}	
None	-	-	0.91	0.27	3.4
Attapulgit	4.0 to 8.0	$\approx 1 \times 0.1^*$	Unstable formulation -viscosity not measured		
Calcium citrate	7.5	$\approx 5.5 \times 1.0$	7660	2.0	3830
TPCAP	4.2	$\approx 10 \times 1.0$	5451	1.11	4910
Glass fiber**	5.0	$\approx 50 \times 5.0$	2.0	0.59	3.4

* From "An Introduction to Clay Colloid Chemistry" by H. van Olphen, Wiley Interscience, Chap. 1, 1977.

** Higher concentrations (75%) of glass fiber tend to convert the formulation into an unpourable paste.

[0076] This example shows that addition of solids of needle morphology improve the viscosity ratio (a measure of shear thinning) only in the case of calcium citrate and TPCAP. Although attapulgit is a needle shaped particle, it destabilizes the formulation while glass fiber does not show any significant effect. Again it is to be emphasized here that calcium citrate and TPCAP has dimensions similar to that of lamellar droplets (3 to 8 μm), whereas attapulgit has smaller dimensions. Also, TPCAP has a larger effect on shear thinning than calcium citrate even at a lower concentration level by weight. Due to the difference in the density of TPCAP (density $\approx 1.4 \text{ g/cc}$) compared to that of calcium citrate (density - 2.3 - 2.4 g/cc), the lower level by weight of TPCAP is equivalent to the higher level by weight of calcium citrate in terms of their level by volume. That is, 7.5 percent calcium citrate tetrahydrate and 4.2 percent TPCAP by weight both amount to about 3 percent by volume of solids. Thus, the higher viscosity ratio obtained for TPCAP is due to its higher ratio of length to width ($10 \times 1.0 \mu\text{m}$) compared to that for calcium citrate tetrahydrate ($5 \times 1.0 \mu\text{m}$).

Example 3

[0077] Effect of different salts on the rheological properties of the model formulation.

Salt		Precipitated Solid (needle)		Viscosity, Pas		Visc. Ratio
Type	Wt. %	Type	in μm	@ 0.2 Pa	@ 21s^{-1}	
None	-	None	-	0.91	0.27	3.4
$\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	5.0	None	-	0.74	0.31	2.4
$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	3.0	Calcium citrate	$\approx 3.0 \times 1.0^*$	175.3	0.92	190.0
$\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$	4.6	Stront. citrate	$\approx 7.5 \times 1.5^*$	101.0	0.70	145.0
BaCl_2	0.75	Barium citrate	>1mm long fibers	Formulation is a paste and not a pourable liq		
Gypsum	4.0	Calcium citrate	$\approx 3 \times 1.0^*$	311.0	1.00	311.0

* Addition of CaCl_2 , SrCl_2 and gypsum caused precipitation of needle shaped particles of calcium citrate in the case of CaCl_2 . Addition of BaCl_2 , on the other hand, resulted in precipitation of solids that were more than 1 mm long.

[0078] This example shows that addition of salts results in a significant increase of viscosity ratio (a measure of shear thinning) only in the case of salts that cause precipitation of needle shaped particles of dimensions similar to that of

lamellar droplets (3 to 8 microns). This example thus shows that the presence of needle shaped particles of dimensions similar to that of lamellar droplets cause enhanced shear thinning (viscosity ratio), no matter whether or not it is added externally, as in the case of calcium citrate and TPCAP, or formed *in-situ* in the formulation by addition of appropriate salts to the formulation. It is to be noted here that 3.0 percent $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ and 4.0 percent gypsum by weight cause in-situ precipitation of 10 percent and 11.5 percent by weight of calcium citrate tetrahydrate. However, the viscosity ratios obtained in these two cases (145 and 311), are lower than that obtained with 7.5 percent by weight of externally added calcium citrate tetrahydrate (viscosity ratio = 3830; Example 2). The calcium citrate tetrahydrate precipitated *in-situ* by addition of $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ and gypsum has a lower ratio of length by width ($3 \times 1.0 \mu\text{m}$) compared to that of externally added calcium citrate tetrahydrate (length by width = $5.5 \times 1.0 \mu\text{m}$) and this can account for the higher viscosity ratio obtained with the latter.

Example 4

[0079] Effect of calcium citrate concentration on the rheological properties of the model formulation.

Calcium Citrate Wt.%	Viscosity, Pas		Viscosity Ratio
	@ 0.2 Pa	@ 21 s ⁻¹	
0.0	0.91	0.27	3.4
4.0	8.0	0.59	6.2
5.0	30.0	0.87	47.1
7.5	7660	2.0	3830

[0080] This example shows that a critical concentration of calcium citrate is needed to obtain a high viscosity ratio. In other words, the increase in viscosity ratio with calcium citrate concentration is not gradual. However, as will be shown in a latter example the critical concentration depends on the surfactants level in the formulation.

[0081] It should be noted that, although only 7.5% calcium citrate is added (versus the equivalent of 11% formed in situ when 3% calcium chloride or 4% gypsum is added as in Example 3), the large difference in viscosity ratio (3830 versus 190 or 311) is probably due to the fact that the calcium citrate is more "needle-like", i.e. has dimension of 5.5 to 1 versus 3.0 to 1.

Example 5

[0082] Effect of gypsum concentration on the rheological properties of the formulation.

Gypsum Wt.%	Viscosity, Pas		Viscosity Ratio
	@ 0.2 Pa	@ 21 s ⁻¹	
0.0	0.91	0.27	3.4
2.5	0.86	0.41	2.1
3.0	31.1	0.65	47.8
4.0	311.0	1.00	311.0

[0083] This example also shows that a critical concentration of gypsum is needed to obtain a high viscosity ratio. As will be shown in a later example, the critical concentration depends on the surfactants level in the formulation. It should be noted in this case addition of gypsum cause precipitation of needle shaped particles of calcium citrate, which is the structuring solid.

Example 6

[0084] Mutual effect of surfactant and gypsum concentrations on the rheological properties of the formulation.

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Surfactant	Gypsum	Viscosity, Pas		Viscosity Ratio
Wt. %	Wt. %	@ 0.2 Pa	@ 21 s ⁻¹	
25.0	4.0	0.18	0.05	3.6
25.0	8.0	93.0	0.30	312.0
37.5	4.0	311.0	1.00	311.0

This example also shows that amount of solids needed to obtain highly shear thinning liquids depend on the surfactant concentration. The structuring solids in this case is needle shaped particles of calcium citrate, which precipitates due to the addition of gypsum to the formulation, of dimensions similar to that of lamellar droplets.

Example 7

[0085] Effect of gypsum in pH - jump high active (Composition A) formulation.

Gypsum Wt. %	Viscosity, Pas		Viscosity Ratio
Wt. %	@ 0.2 Pa	@ 21 s ⁻¹	
*0.0	11.4	0.8	14.3
3.0	1210	0.92	1315
4.0	1700	1.4	1214

* It should be noted that the composition contains 14.0 wt. % TPCAP platelets. However, as seen, the TPCAP platelets do not significantly increase viscosity ratio.

[0086] This example shows that addition of gypsum, which results in precipitation of calcium citrate needles, increases the viscosity ratio also in the high active pH jump formulation.

Example 8

[0087] Effect of gypsum in pH - jump low active (Composition B) formulation.

Gypsum Wt. %	Viscosity, Pas		Viscosity Ratio
Wt. %	@ 0.2 Pa	@ 21 s ⁻¹	
0.0	Unstable formulation		
4.0	1.93 x 10 ⁴	2.45	7878
8.0	1 x 10 ⁵	2.8	35714

[0088] This example shows that gypsum addition increases the viscosity ratio even in the low active pH jump formulation. Furthermore, low active pH jump formulation is not stable without gypsum addition.

Example 9

[0089] The stability of large size particles in lamellar liquids with structuring needle-shaped particles was compared with lamellar liquids without its structuring needle-shaped particles. 500-1000 µm size enzyme capsules were suspended in a duotropic liquid (with and without structuring particles of invention) with a density difference of 0.05 to 0.15 specific gravity units and results were as follows:

Suspending Medium		Visual
Observation		
I.	Model formulation A with no needle-shaped sides (37.5 wt% total surfactants)	Capsule separation occurred overnight (~ 16 hrs.)

(continued)

Suspending Medium		Visual
Observation		
II.	Model form. A with 4 wt.% added gypsum (37.5 wt.% total surfactants).	No capsule separation even after 12 months
III.	pH-jump (high active) form. B with 14 wt.% of 30 wt.% slurry of TPCAP platelets	Capsule separation occurred overnight (~ 16 hrs.)

[0090] This example clearly shows that lamellar structurant, duotropic liquid alone is not sufficient to suspend large size particles such as enzyme capsules. Only when the structuring particles of invention are added can the large size particle (e.g., 500-1000 microns) be suspended.

[0091] Thus, in formulations I (not pH-jump) and III (pH-jump) where no structuring particles were added, capsule separation occurred within 16 hours. By contrast, when the suspending particles of the invention were added (formulation II), no separation was seen even after 12 months.

Claims

1. A heavy duty liquid composition comprising:

- (a) from greater than 15% to 80% by weight of a surfactant;
- (b) from 1 to 25% by weight of solid particles added directly or formed in situ; and
- (c) an electrolyte,

wherein the solid particles have a length of from 3 to 25 μm , wherein the width of the solid particles is less than 1 μm and the length of the solid particles is at least 3 times the width, preferably at least 5 times the width, and no less than 3 μm .

2. A composition according to claim 1, wherein the length of the particle is 3 to 20 times the width.

3. A composition according to claim 1 or 2, wherein the composition comprises a structure of lamellar droplets.

4. A composition according to any of claims 1-3, capable of suspending particles from 200 to 1000 μ in size.

5. A composition according to any of claims 1-4, wherein the surfactant is present at a concentration of more than 20% by wt., wherein the surfactant is selected from the group consisting of anionics, nonionics, cationics, zwitterionics, amphoterics and mixtures thereof, wherein the electrolyte is present at a concentration of 0.1 - 60% by wt., wherein the composition further comprises 0.1 to 5% by wt. deflocculating polymer, and wherein the composition is capable of suspending solid particles up to 1000 μm in size.

6. A composition according to claim 5, further comprising 1-25% by wt of an alcohol selected from the group consisting of sorbitol, catechol, galactitol, fructose and pinacol; 0.5 to 10.0% by wt. borate or boron component; and 0.5 - 10.0% wt. bleach component.

Patentansprüche

1. Flüssige Vollwaschmittelzusammensetzung, umfassend:

- (a) mehr als 15 % bis 80 Gew.-% eines Tensids;
- (b) 1 bis 25 Gew.-% fester Teilchen, die direkt zugegeben oder in situ gebildet werden, und
- (c) einen Elektrolyt,

worin die festen Teilchen eine Länge von 3 bis 25 μm aufweisen, wobei die Breite der festen Teilchen weniger als 1 μm ist und die Länge der festen Teilchen mindestens das 3fache der Breite, vorzugsweise mindestens das 5fache der Breite und nicht weniger als 3 μm beträgt.

2. Zusammensetzung nach Anspruch 1, wobei die Länge des Teilchens das 3- bis 20fache der Breite beträgt.
3. Zusammensetzung nach Anspruch 1 oder 2, wobei die Zusammensetzung eine Struktur von lamellaren Tröpfchen umfasst.
4. Zusammensetzung nach einem der Ansprüche 1 bis 3, die Teilchen mit einer Größe von 200 bis 1000 µm suspendieren kann.
5. Zusammensetzung nach einem der Ansprüche 1 bis 4, wobei das Tensid bei einer Konzentration von mehr als 20 Gew.-% vorliegt, wobei das Tensid aus der Gruppe, bestehend aus anionischen, nichtionischen, kationischen, zwiterionischen, amphoteren Tensiden und Gemischen davon, ausgewählt ist, wobei der Elektrolyt mit einer Konzentration von 0,1 bis 60 Gew.-% vorliegt, wobei die Zusammensetzung weiterhin 0,1 bis 5 Gew.-% Entflockungspolymer umfasst, und wobei die Zusammensetzung feste Teilchen mit einer Größe von bis zu 1000 µm suspendieren kann.
6. Zusammensetzung nach Anspruch 5, weiterhin umfassend 1 bis 25 Gew.-% eines Alkohols, ausgewählt aus der Gruppe, bestehend aus Sorbit, Brenzcatechin, Galactit, Fructose und Pinacol, 0,5 bis 10,0 Gew.-% Borat oder Borkomponente und 0,5 bis 10,0 Gew.-% Bleichmittelkomponente.

Revendications

1. Composition liquide à usage professionnel comprenant :

- (a) de plus de 15 % à 80 % en poids d'un tensioactif ;
- (b) de 1 à 25 % en poids de particules solides ajoutées directement ou formées in situ ; et
- (c) un électrolyte

dans laquelle les particules solides ont une longueur allant de 3 à 25 µm, dans laquelle la largeur des particules solides est inférieure à 1 µm et la longueur des particules solides est au moins 3 fois égale à leur largeur, de préférence au moins 5 fois égale à leur largeur, et n'est pas inférieure à 3 µm.

2. Composition selon la revendication 1, dans laquelle la longueur de la particule est 3 à 20 fois égale à sa largeur.

3. Composition selon la revendication 1 ou 2, dans laquelle la composition comprend une structure de gouttelettes lamellaires.

4. Composition selon l'une des revendications 1 - 3, capable de mettre en suspension des particules ayant une taille allant de 200 à 1.000 µ.

5. Composition selon l'une des revendications 1 - 4, dans laquelle le tensioactif est présent à une concentration supérieure à 20 %, en poids, dans laquelle le tensioactif est sélectionné à partir du groupe composé des tensioactifs anioniques, non ioniques, cationiques, zwiterioniques, amphotères et des mélanges de ceux-ci, dans laquelle l'électrolyte est présent à une concentration de 0,1 - 60 % en poids, dans laquelle la composition comprend en outre de 0,1 à 5 % en poids d'un polymère défloculant et dans laquelle la composition est capable de mettre en suspension des particules solides ayant une taille allant jusqu'à 1.000 µm.

6. Composition selon la revendication 5, comprenant en outre de 1 à 25 % en poids d'un alcool sélectionné à partir du groupe composé du sorbitol, du catéchol, du galactitol, du fructose et du pinacol ; de 0,5 à 10 % en poids de borate ou d'un composant de bore ; et de 0,5 à 10,0 % en poids d'un composant de blanchiment.



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